ARMORED MEDICAL RESEARCH LABORATORY

FORT KNOX, KENTUCKY

PROJECT NO. 5 - CREW FATIGUE RESEARCH

Sub-Project No. 5-20 - Study of Schedules, Duration and Discipline of Rest Periods for Tank Crews on Long Marches

INFORMATION COPY

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9 May 1944

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1. PROJECT: No. 5 - Crew Fatigue Research - Sub-Project #5-20, Study of Schedules, Duration and Discipline of Rest Periods for Tank Crews on Long Marches.

a. Authority - First indorsement, letter Commanding General, Headquarters Armored Force, Fort Knox, 400.112/6 GNOHD dated September 24,1942.

b. Purpose - To determine the causes of fatigue in men on long marches and failure to complete assigned marches.

2. DISCUSSION:

a. In spite of the tremendous mechanization of modern warfare, objectives are still ultimately occupied by infantry. Even under the most optimal circumstances their final tasks are accomplished on foot.

b. Frequently it is advantageous to move men rapidly on foot over long distances. The advantage is not real unless troops are able to fight efficiently after having completed the march.

c. Many enviable records have been set of great distances which men have marched in a single day; yet little or no mention is ever made of the cost in combat efficiency of having accomplished such feats of endurance, and little study has been made of the ability of troops to repeat such performances day after day.

d. These facts, together with the observed difficulties of troops attempting a single 25 mile road march during basic training at the ARTC, lead to a study of the nature of fatigue in men on long marches and the causes of failure to complete the assignment.

e. Repeated marches of increasing length were studied rather than single record performances.

f. For details of the experimental procedure and results, see Appendix.

3. CONCLUSIONS:

a. Repeated daily marching over distances which are practical and feasible for the movement of the supplies of an army do not cause serious fatigue in men properly trained, fed and rested. A group of 12 men marched 480 miles in five weeks and completed the last 125 miles in five days without evidence of undue fatigue.

b. The causes of casualties or failure to complete an assigned march, are foot defects and not general fatigue.

c. Healthy, normal young men (ages 18 to 35) with normal feet, good footgear and proper foot care can be trained to perform long marches daily without casualties.

d. Men with anatomical foot defects cannot perform long marches daily without casualties.

e. The causes of "falling out" on long marches are:

(1) Bad feet
(2) Improper Footgear
(3) Inadequate foot care
(4) Inadequate training
(5) Improper management of men as regards food, rest and shelter.

f. Mechanized units which in battle will ultimately be called upon to march must specifically train for marching. Ability to march does not necessarily develop as a by-product of miscellaneous physical activity.

g. Long marches should not be undertaken by any units without a thorough study of feet and footgear, together with adequate training in foot care. They are no less important than the rifle.

4. RECOMMENDATIONS:

a. That the information in this report be made available to theater and training commanders.

b. That thorough training in long marches be included in the training of mechanized units.

c. That no long marches be undertaken without a thorough study of the foot and footgear of all personnel involved.

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Experimental Procedure and Results

APPENDIX

MARCHING FATIGUE EXPERIMENT

1. Personnel:

a. Nineteen (19) men employed in this study were picked at random from the 777th Tank Battalion, nine (9) from the Hq. Co. and ten (10) from the Service Co. These men had been in the Army an average of 15.2 months (range 6 to 38 months). All had been transferred to their present organization from other outfits and were very definitely not the "cream of the crop". None had had any extensive marching since basic training. Their ages ranged from 18 to 39 years (avg. 23.9 years), height from 67" to 74" (avg. 70.4 with shoes) and weight from 140 to 198 lbs. (avg. 160.25 lbs.).

b. Prior to starting the experiment, each man was given a physical examination with special emphasis on the feet. Nine (9) men had no foot defects, nine (9) showed obvious anatomical foot defects and one was eliminated because of an active infectious disease.

c. The foot defects consisted of the following:

(1) First degree flat feet - 2
(2) Same plus protrusion of cuboid - 1
(3) Same plus tenderness at metarsal heads - 1
(4) Third degree flat feet plus callous - 1
(5) Same plus short Achilles tendon - 1
(6) Short Achilles tendon plus callouses - 1
(7) Second degree flat feet plus medial luxation of foot - 1
(8) Bunion plus blisters - 1 (evidences of old blisters not considered a foot defect.)

d. During the experiment, men slept in a standard barracks, they ate as desired in their regular mess, wore fatigue and winter combat clothing as desired and carried a twenty pound pack plus raincoat and canteen during all marches. Water was permitted as desired throughout the experiment.

2. Experimental Program:

a. The first two weeks were spent in physical conditioning. The program consisted of 30 minutes calisthenics, two one-hour periods of close order drill, one hour on an obstacle course and gradually increasing road marches of from 4 to 9 miles each day for six days a week. During this period, six men dropped from the experiment, three for reasons not associated with the tests and three because of blisters, painful feet and increasing anatomical defects. In all of these last three men, obvious foot defects were found at the time of physical examination.

b. The actual test program began with thirteen men, nine of whom

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had normal feet and the other four were known to have minor foot defects.

c. In the first two weeks of the test program the men made daily road marches of the distance in miles indicated in the following table:

TIME	M	T	W	TH	F	S	TOTAL
A.M.	2	7	14	7	19	3	
P.M.	5	5		5			67
NIGHT	3	2	5	2	0		12
TOTAL	10	14	19	14	19	3	79

d. All road marches were made at a marching rate of 3.0 mph, walking 50 minutes and resting ten. Noon rests were one hour. On Wednesday and Friday, men ate K ration at noon enroute. At all other times, they returned to their barracks for meals. Each man walked an additional 10 miles daily to and from mess.

e. In the second two-week period, the same schedule was followed except that the men were allowed to determine their own pace and length of rest periods.

f. During this four week period, half of the marching was done on finished roads and half cross country. The work was done in January. Approximately half the time, the weather was clear and cold (20° - 40° F.). The other half, there was either rain or snow daily.

g. During the fifth and final week of the experiment, the men marched 25 miles daily for five consecutive days at their own pace determining their own rest periods. No effort was made to keep the group together and stragglers came in as they chose. Again half the route was on finished roads and half cross-country. The ground was very wet and muddy throughout the week.

3. Data:

a. Daily determination of stripped weights were made throughout the experiment.

b. The rectal temperature and standing pulse rate were measured before and after each march. The actual weight loss during the march was measured and urine specimens before and after work were examined for evidences of albumen, sugar and ketone bodies.

c. Men with any complaints were examined by a medical officer daily and all men were seen twice daily in the final week (125 miles in 5 days).

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4. Results:

a. During the first two weeks of the test program, one additional man was dropped because of his refusal to carry out instructions and because of his deleterious effect upon the morale of the group. The remaining 12 completed part or all of the five week test program during which they marched 480 miles. In the last five days, they marched 125 miles and all, by their own request, went to a U.S.O. dance on the evening before the last day. All finished the final hike without difficulty in an elapsed time of 7 hours and 45 minutes. In the last week, the group showed an average weight gain of two pounds each, and no man lost weight during this period.

b. Marching rate and rest periods.

(1) Early in the experiment, the men expressed the feeling that marching rates of 2.5 mph and 3 mph were a little too slow for comfort on finished roads. Also they complained rather bitterly about being forced to take a ten minute rest period each hour. Because the weather was cold and often wet, the men felt that the rest period made them stiff and uncomfortable thereby doing more harm than good.

(2) In the second two-week period, the men selected their own marching rate and determined their own rest periods. Over this two-week period and the final week, the marching rate as determined by total distance and elapsed time varied between 2.8 and 3.2 miles per hour, depending on the terrain and mud. Rest periods were limited to five minutes in the morning and were not changed in the afternoon if the weather was cold; but were frequently 10 minutes if adequate shelter could be found. Occasionally men preferred to march two full hours without a break followed by a 15 minute rest under shelter before proceeding. Most men felt that a break at the end of the first hour in the morning was wholly unnecessary except to adjust socks and have a drink.

c. Casualties occurred from time to time during the first four week period. In all but one case the cause was foot trouble. This man developed severe irritation between his thighs and buttocks. He was off duty two days and then continued throughout the experiment without difficulty. Three men were unable to wear leggings because they rubbed the calf or shin-bone raw. No time was lost. In no case, did any man drop out because of general physical exhaustion. Those who dropped out or fell behind did so solely because of painful feet (or legs improperly used because of a foot lesion).

(1) No man who had normal feet to start with had to drop out because of foot trouble. Four of these did develop blisters which were treated successfully without interference to their activities. In all cases, slightly larger shoes and the use of cushion-sole socks prevented any further trouble.

(2) All of the men with anatomical foot trouble had sore, tender

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and bruised feet roughly in proportion to the extent of the original lesion. The men with short Achilles tendons had great trouble early, but were all right by the end of the period. The men with flat feet lost, on the average, 25% of the work time. All were offered the chance to drop out entirely and refused. By judicious care and foot exercises, all were doing at least 3/4 of the program at the end of a month and two were much better than before they started. Almost all of these men had poorly fitting shoes, wore inadequate socks and knew nothing about foot care.

d. The temperature and pulse data added nothing of practical value. The urine showed increasing amounts of albumen and ketone bodies as the length of the march increased. These evidences of fatigue for any given march were definitely less or even absent in the fourth week as compared with the first week - evidence of improved physical condition or increased work efficiency. In no instance was the condition of significant severity and it always cleared up entirely before the next day's work. Weight losses per mile marched were slightly greater in the men with bad feet. The group average weight loss seemed to be more a function of the average ambient temperature than of the length of the march. It was never as much as 5% of the body weight. The group lost weight during the training period and the first two weeks of the experimental period. Thereafter, there was a steady weight gain.

e. In the final week, the men marched 25 miles daily for five consecutive days, each day over a different course. Marching rates based on total elapsed time were as follows:

(1) 2.78 mph
(2) 3.1 mph
(3) 3.1 mph
(4) 2.9 mph
(5) 3.2 mph

Rest periods during the hike were as follows:

(1) End of 1 hour - 3 min.
(2) End of 2 hours - 5 min.
(3) End of 3½ hours - 40 min. lunch
(4) End of 5½ hours - 10 min.
(5) End of 6½ hours - 8-12 min.

Eight men finished all of the hikes without difficulty. Two men finished four of the hikes and completed 20 miles of the other one. One man completed three; did 20 miles, and 10 miles on the other two. One man completed two hikes; did 10 miles, 18 miles and 20 miles respectively on the other three. All men finished the first and fifth hikes. All incompleted hikes were due

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to sore feet and blisters rather than to fatigue. Those who did not complete all hikes were men with apparent anatomical foot defects. There was an average weight gain during this week of 2 lbs. each, and no man lost weight. Albumen and acetone in the urine were less on the fifth day than on the first. All twelve went to a dance on the evening of the 4th day and all twelve finished the hike of the 5th day in a group.

5. Summary:

a. The purpose of the experiment was to find out how far trained men can march; and, when fatigue stops them, what are the manifestations of that fatigue.

b. Serious fatigue never appeared and the only limiting factors were the condition of the feet and footgear.

c. All of these men could have fought for their lives at the end of 125 miles marching in five days.

d. Men without foot defects thoroughly trained for marching, given proper and adequate food and rest, can move forward without undue fatigue at rates and over distances greatly in excess of those commonly accepted.

e. The experiment was stopped not because the men had done too much, but because it seemed impractical to go farther. All were willing and able to attempt 35 miles per day (10.5 hours).

f. The ability to perform repeated long marches requires training for that task and it is fallacious for mechanized units or any others to assume that marching ability will necessarily come as a natural by-product of miscellaneous hard physical activity.

g. No unit, mechanized or otherwise, should be required to take long marches unless there has been a thorough study of feet and footgear, together with detailed training in foot care. The feet are no less important than the rifle to the infantryman.

APPENDIX

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